

AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions and listings of claims in the application:

1. (Previously Presented) A semiconductor device comprising:

a Cu film provided above a main surface of a semiconductor substrate and used as a wiring;

an intermediate layer formed at least on the Cu film, the intermediate layer comprising a TaN film formed on the Cu film and a Ta film formed on the TaN film, wherein a thickness of the TaN film is 20 nm or more; and

an Al film formed on the Ta film and used as a pad.

2. (Original) The semiconductor device according to claim 1, wherein the intermediate layer has a first portion which contacts the Cu film and a second portion which does not contact the Cu film, and an insulating film contacts the second portion.

3. – 12. (Canceled)

13. (Previously Presented) The semiconductor device according to claim 1, wherein a thickness of the Ta film is 5 nm or less.

14. (Canceled)

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15. (Previously Presented) The semiconductor device according to claim 1, wherein a thickness of the TaN film is 40 nm or more.

16. (Currently Amended) A semiconductor device comprising:
a Cu film provided above a main surface of a semiconductor substrate and used as a wiring;
an intermediate layer formed at least on the Cu film, the intermediate layer comprising a TaN film formed on the Cu film and a Ta film formed on the TaN film;
an Al film formed on the Ta film and used as a pad, the Al film having ~~an~~ a horizontally extending portion under which the Cu film is not formed; and
a conductive connection member connected to the Al film at the horizontally extending portion.

17. (Previously Presented) The semiconductor device according to claim 16, wherein the intermediate layer has a first portion which contacts the Cu film and a second portion which does not contact the Cu film, and an insulating film contacts the second portion.

18. (Previously Presented) The semiconductor device according to claim 16, wherein the intermediate layer has a portion corresponding to the extending portion.

19. (Previously Presented) The semiconductor device according to claim 16, wherein the conductive connection member includes a bonding wire.

20. (Previously Presented) The semiconductor device according to claim 16, wherein a thickness of the Ta film is 5 nm or less.

21. (Previously Presented) The semiconductor device according to claim 16, wherein a thickness of the TaN film is 20 nm or more.

22. (Previously Presented) The semiconductor device according to claim 16, wherein a thickness of the TaN film is 40 nm or more.

23. (New) The semiconductor device according to claim 1, wherein the Al film has a plurality of vertically extending portions extending toward the Cu film, and wherein the intermediate layer has a plurality of portions provided between the vertically extending portions and the Cu film.

24. (New) The semiconductor device according to claim 23, further comprising an insulating film surrounding each of the vertically extending portions.

25. (New) The semiconductor device according to claim 16, wherein no conductive connection member is connected to that portion of the Al film under which the Cu film is formed.

26. (New) The semiconductor device according to claim 16, wherein the Al film has a plurality of vertically extending portions extending toward the Cu film, and wherein the

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intermediate layer has a plurality of portions provided between the vertically extending portions and the Cu film.

27. (New) The semiconductor device according to claim 26, further comprising an insulating film surrounding each of the vertically extending portions.

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REMARKS

By this Amendment, Applicants amend claim 16 to more particularly define the invention and add new claims 23-27 to protect additional aspects related to the present invention.

In the Office Action ("OA"), the Examiner rejected claims 1, 2, 14¹, and 15 under 35 U.S.C. § 102(e) as anticipated by Stamper et al., U.S. Publication No. 2002/0053746 ("Stamper"); rejected claims 1, 2, 14, and 15 under 35 U.S.C. § 102(e) as anticipated by Chittipeddi et al., U.S. Publication No. 2001/0036716 ("Chittipeddi"); rejected claim 13 under 35 U.S.C. § 103(a) as unpatentable over Stamper; rejected claims 16-22 under 35 U.S.C. § 103(a) as unpatentable over Stamper in view of Galloway, U.S. Patent No. 5,783,868 ("Galloway"); rejected claim 13 under 35 U.S.C. § 103(a) as unpatentable over Chittipeddi; and rejected claims 16-22 under 35 U.S.C. § 103(a) as unpatentable over Chittipeddi in view of Galloway. Applicants address these rejections below.

I. Response to Rejection under 35 U.S.C. § 102(e) over Stamper

The Examiner alleged that claims 1, 2, and 15 are anticipated by Stamper. Applicants claimed a foreign priority date of March 27, 2000 based on JP 2000-086383, which antedates the earliest U.S. filing date of Stamper's parent application, May 4, 2000. Applicants filed a Supplemental Response on May 30, 2003 in which a certified translation of JP 2000-086383 was submitted to remove Stamper as prior art. Accordingly, Applicants respectfully request that the Examiner reconsider this rejection in view of the certified translation and withdraw the rejection of claims 1, 2, and 15 under section 102(e) over Stamper.

¹ Claim 14 was canceled by the Amendment dated October 18, 2002.

II. Response to Rejection under 35 U.S.C. § 102(e) over Chittipeddi

The Examiner alleged that claims 1, 2, and 15 are anticipated by Chittipeddi. In response Applicants respectfully submit that Chittipeddi fails to anticipate claims 1, 2, and 15.

In order to properly anticipate Applicants' claimed invention under 35 U.S.C. § 102(e), each and every element of the claim in issue must be found, either expressly described or under principles of inherency, in a single prior art reference. Furthermore, "[t]he identical invention must be shown in as complete detail as is contained in the ... claim." M.P.E.P. § 2131 (8th Ed., Aug. 2001) (quoting *Richardson v. Suzuki Motor Co.*, 868 F.2d 1126, 1236, 9 U.S.P.Q.2d 1913, 1920 (Fed. Cir. 1989)). Finally, "[t]he elements must be arranged as required by the claim." M.P.E.P. § 2131 at p. 2100-69.

Claim 1 is directed to semiconductor device comprising a combination of elements including, *inter alia*, "an intermediate layer formed at least on [a] Cu film, the intermediate layer comprising a TaN film formed on the Cu film and a Ta film formed on the TaN film, wherein a thickness of the TaN film is 20 nm or more."

In rejecting this claim, the Examiner alleged that Chittipeddi teaches an intermediate layer 55 formed on a Cu film and comprising a 20nm or more TaN film and a Ta film formed on the TaN film. (OA at ¶ 5.) Contrary to the Examiner's allegations, Applicants respectfully submit that Chittipeddi only teaches a TaN/Ta barrier layer with a thickness of 10 nm to 100 nm but does not specifically teach that the TaN film of the TaN/Ta barrier layer is formed to be 20 nm or more.

Chittipeddi is directed to a semiconductor device having gold wires bonded to copper. Chittipeddi discloses that the semiconductor device comprises a copper plug 44 with a barrier layer 41(patterned layer 55) formed on copper plug 44. Chittipeddi, ¶ 15. Chittipeddi recites that "[t]he preferred material for barrier layer 41 is Ta, TaN, Ti, or TiN ... [and] [a] 100 to 1000

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Angstrom layer is suitable". Chittipeddi, ¶ 11. Furthermore, Chittipeddi discloses depositing a barrier layer where "said barrier layer [is] a material selected from the group consisting of Ta, TaN, Ti, TiN, and combination thereof." Chittipeddi, claim 1. From these descriptions, Chittipeddi discloses that a barrier layer may be formed of a stacked layer of a Ta film and a TaN film, and the barrier layer has a total thickness of 10-100 nm. However, Chittipeddi clearly does not teach that the thickness of the TaN film of the stacked layer of the Ta film and TaN film is 20 nm or more.

Thus, Chittipeddi fails to teach at least that "a thickness of the TaN film is 20 nm or more" as recited in claim 1. Accordingly, Chittipeddi fails to anticipate claim 1. For at least this reason, claim 1 is allowable.

Claims 2 and 15 are allowable at least due to their dependence from allowable claim 1.

III. Response to Rejection under 35 U.S.C. § 103(a) over Stamper

The Examiner alleged that claim 13 is unpatentable over Stamper. As mentioned above, Applicants filed a Supplemental Response on May 30, 2003 in which a certified translation of JP 2000-086383 was submitted to remove Stamper as prior art. Accordingly, Applicants respectfully request that the Examiner reconsider this rejection in view of the certified translation and withdraw the rejection of claim 13 under section 103(a) over Stamper.

IV. Response to Rejection under 35 U.S.C. § 103(a) over Stamper and Galloway

The Examiner alleged that claims 16-22 are unpatentable over Stamper in view of Galloway. As mentioned above, Applicants filed a Supplemental Response on May 30, 2003 in which a certified translation of JP 2000-086383 was submitted to remove Stamper as prior art. Accordingly, Applicants respectfully request that the Examiner reconsider this rejection in view of the certified translation and withdraw the rejection of claims 16-22 under section 103(a) over Stamper in view of Galloway.

V. Response to Rejection under 35 U.S.C. § 103(a) over Chittipeddi

The Examiner alleged that claim 13 is unpatentable over Chittipeddi. In response, Applicants submit that a *prima facie* case of obviousness has not been established for claim 13 because Chittipeddi fails to teach or suggest all the elements of claim 13.

In order to establish a *prima facie* case of obviousness, three basic criteria must be met. First, the prior art reference (or references when combined) must teach or suggest all the claim elements. Furthermore, "[a]ll words in a claim must be considered in judging the patentability of that claim against the prior art." M.P.E.P. § 2143.03 (quoting *In re Wilson*, 424 F.2d 1382, 1385, 165 U.S.P.Q. 494, 496 (C.C.P.A. 1970)). Second, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify a reference or to combine reference teachings. Third, there must be a reasonable expectation of success. See M.P.E.P. § 2143 at pp. 2100-122 to 127.

Claim 13 depends from claim 1 and, thus, incorporates all of the elements of that claim. As mentioned above, Chittipeddi fails to teach at least that "a thickness of the TaN film is 20 nm or more" as recited in claim 1 and incorporated in claim 13. (See current Amendment, **Remarks** section II.) Thus, a *prima facie* case of obviousness has not been established for claim 13 because Chittipeddi fails to teach or suggest all the claim elements. For at least this reason, claim 13 is allowable.

VI. Response to Rejection under 35 U.S.C. § 103(a) over Chittipeddi and Galloway

The Examiner alleged that claims 16-22 are unpatentable over Chittipeddi in view of Galloway. In response, Applicants submit that a *prima facie* case of obviousness has not been established for these claims because Chittipeddi and Galloway, taken alone or in combination, fail to teach or suggest all the claim elements, no motivation or suggestion would exist to combine, and no reasonable expectation of success would exist.

Claim 16 is directed to a semiconductor device comprising a combination of elements including, *inter alia*, “an Al film formed on [a] Ta film and used as a pad, the Al film having a horizontally extending portion under which [a] Cu film is not formed; and a conductive connection member connected to the Al film at the horizontally extending portion.”

As mentioned above, Chittipeddi is directed to a semiconductor device with gold wires bonded to copper. Chittipeddi discloses that the semiconductor device comprises a copper plug 44 with a barrier layer 41(patterned layer 55) formed on the copper plug. Additionally, Chittipeddi discloses that an Al layer 52 (patterned layer 56) is formed over patterned barrier layer 55. Chittipeddi discloses that patterned Al layer 56 partially extends beyond copper plug 44. *See* Chittipeddi, Fig. 20. However, Chittipeddi discloses that a bonding wire 61 is connected to patterned Al layer 56 directly over copper plug 44 but is not connected to the extending portion of Al layer 56. Therefore, Chittipeddi fails to teach or suggest at least “a conductive connection member connected to the Al film at the horizontally extending portion” as recited in claim 16.

In fact, the Examiner admitted that Chittipeddi fails to disclose that a conductive connection member is connected at an extending portion of the pad under which the copper film is not formed. (OA at ¶ 19.) Nonetheless, the Examiner alleged that Galloway utilizes a conductive connection member connected at an extending portion of the pad under which a copper film is not formed. (OA at ¶ 10). The Examiner states that “[i]t would have been obvious ... to incorporate an extending portion to the pad of Chittipeddi and to attach the conductive member to said extending portion in order to eliminate device damage as taught by Galloway.” (OA at ¶ 21.) Contrary to the Examiner’s allegation, Applicants submit that

Galloway when taken alone or in combination with Chittipeddi fails to teach or suggest the invention recited in claim 16.

Galloway discloses a semiconductor device including a metal layer 12 having an extension area 12a connected to an original wire bond pad 16 and a metal bump 24 connected to metal layer 12 above wire bond 16. Galloway, Fig. 5. Galloway further discloses that, in burn-in testing, a wire bond 92 is connected to extension area 12a, to thereby prevent pad 16 from being damaged due to the connection of wire bond 92. Galloway, col. 4, line 47, to col. 5, line 5. However, in Galloway, the conductive connection member is a metal bump 24 connected to the metal layer 12, not wire bond 92. In fact, wire bond 92 is removed after burn-in testing. Thus, Galloway fails to teach or suggest at least “a conductive connection member connected to the Al film at the horizontally extending portion” as recited in claim 16.

Furthermore, Galloway discloses that pad 16 is formed of aluminum or aluminum alloy with a barrier layer 20 interposed between metal layer 12 and pad 16. Galloway, col. 2, lines 54-56. In any combination of Galloway and Chittipeddi, pad 16 of Galloway would correspond to aluminum bond pad 56 of Chittipeddi. Thus, if Galloway could be combined with Chittipeddi (which Applicants do not concede), metal layer 12 disclosed in Galloway would be connected to the upper surface of pad 56 disclosed in Chittipeddi with barrier layer 20 interposed between metal layer 12 and pad 56. In other words, the metal layer with the extension portion would not be an extension of pad 56 but would be a separate component with barrier layer 20 formed between. Thus, the combination of Galloway and Chittipeddi would not produce an Al film with a horizontally extending portion.

Therefore, Chittipeddi and Galloway, when taken alone or in combination, fail to teach or suggest at least “an Al film formed on [a] Ta film and used as a pad, the Al film having a

horizontally extending portion under which [a] Cu film is not formed; and a conductive connection member connected to the Al film at the horizontally extending portion,” as recited in claim 16. Accordingly, a *prima facie* case of obviousness has not been established for claim 16. For at least this reason, claim 16 is allowable.

Moreover, no motivation or suggestion would exist to combine Galloway with Chittipeddi. The Examiner states that “[i]t would have been obvious ... to incorporate an extending portion to the pad of Chittipeddi and to attach the conductive member to said extending portion in order to eliminate device damage as taught by Galloway.” (OA at ¶ 21.) Contrary to the Examiner’s allegations, the combination of Galloway and Chittipeddi would not prevent damage to the pad of Chittipeddi.

As mentioned above, Galloway discloses that a metal bump 24 is connected to metal layer 12 above wire bond 16. Since pad 16 is formed under metal bump 24, there is a risk that pad 16 may be damaged when metal bump 24 is connected to metal layer 12. Therefore, the combination of Galloway with Chittipeddi would not prevent damage to the pad as alleged by the Examiner. Thus, no motivation or suggestion would exist to combine Galloway with Chittipeddi. Since no motivation or suggestion would exist to combine, no reasonable expectation of success would exist. Accordingly, a *prima facie* case of obviousness has not been established for claim 16. For at least this reason, claim 16 is allowable.

Claims 17-22 are allowable at least due to their dependence from allowable claim 16. “If an independent claim is nonobvious under 35 U.S.C. 103, then any claim depending therefrom is nonobvious.” M.P.E.P. § 2143.03 at p. 2100-126 (citing *In re Fine*, 837 F.2d 1071, 5 U.S.P.Q.2d 1596 (Fed. Cir. 1988)).

VII. New claims

Applicants add new claims new claims 23-27 to protect additional aspects related to the present invention. New claims 23 and 24 depend either directly or indirectly from independent claim 1. Claims 25-27 depend either directly or indirectly from independent claim 16. As mentioned in the preceding paragraphs, claims 1 and 16 are allowable over the cited prior art. Accordingly, Applicants submit that new claims 23-27 are allowable at least due to their dependence from either claim 1 or claim 16.

VIII. Conclusion

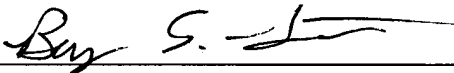
In view of the foregoing, Applicants respectfully request reconsideration and reexamination of this application and the timely allowance of the pending claims.

Please grant any extensions of time required to enter this response and charge any additional required fees to our deposit account 06-0916.

Respectfully submitted,

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Dated: September 3, 2003

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